Southeast Alaska Jökulhlaups

By Aimee Devaris

Jökulhlaup, an Icelandic term pronounced *YO-kul-hloip*, refers to a flood resulting from the breaching of a glacier-dammed lake (*jökull* meaning "glacier," *hlaup* meaning "flood burst"). There are at least two locations in Southeast Alaska where these events are known to occur with regularity: the Tulsequah Glacier near Juneau and the Salmon Glacier near Hyder.

Glacier-dammed lakes in Southeast Alaska are a lingering result of the Little Ice Age. Fluctuations in the ice field, that still grips the Coast Mountain Range, create these lakes which may be located between glacier and valley walls, beneath or inside the glacier, or on top of the glacier. The lakes, filled with rainfall and meltwater, may drain abruptly due to a number of factors. The most common reason is a combination of melting and floating of the ice dam by increasing water levels in the lake, allowing water to flow out near the base of the glacier. In some cases, jökulhlaups have been caused by geothermal warming.

The Tulsequah Glacier, located on the eastern rim of the Juneau Icefield near the Devil's Paw, impounds two lakes which have a long history of swift releases into the Tulsequah and Taku Rivers. Tulsequah Lake formed in the late 19th or early 20th century when a tributary glacier separated from the trunk of the Tulsequah Glacier. By the 1920s, Tulsequah Lake grew substantially due to the further recession of the tributary glacier(s), and some of the largest recorded outburst floods occurred during this period. In the late 1950s, the water level in Tulsequah Lake had dropped enough to create an upper moraine-dammed lake appropriately named Upper Tulsequah Lake. According to Canadian geologists and observers, the volume of water released annually (usually in July) from Tulsequah Lake has continued to decline. And for at least the past decade, the noteworthy jökulhlaups that have impacted the Tulsequah and Taku River basins are coming from a second glacier-dammed lake known as Lake Nolake.

Lake Nolake is located about five miles north of Tulsequah Lake, further "up" the Tulsequah Glacier. (See Photo 1.) This glacier-dammed lake has grown dramatically since it was first mapped. The British Columbia Ministry of Forests estimates that Lake Nolake has increased tenfold in size since 1958 and now covers an area of about 4.8 square kilometers. (See Photos 2 and 3.) Lake depth measurements taken during the late 1990s provide a lake volume estimate of about 720 million cubic meters, which is approaching Tulsequah Lake at its largest capacity many years ago.

The largest known increase in Lake Nolake's area occurred during the summer of 1993 when a large slab of the Tulsequah Glacier calved into the lake. The slab (500 by 700 meters in area and 170 meters thick) may have actually been an ice tongue that had been "floating" on the surface of the lake until that point. Due to its increased dimensions, Lake Nolake now takes longer to fill. (See Photo 4.) Thus, the associated jökulhlaup usually occurs in August or September.

The following table gives the known dates and sources of the outburst floods that have taken place along the Tulsequah Glacier. These data have been compiled from the British Columbia Ministry of Forests, the owners of the Tulsequah mine property, the Canadian Geological Survey and the United States Geological Survey (USGS). Because the USGS was not aware that Lake Nolake was contributing to the flood cycle on the Taku River, they attributed all known floods to Tulsequah Lake. Those events are noted with a question mark in the table, because it is possible that some or all of them may actually be Lake Nolake outbursts.

Year	Lake	Date	Year	Lake	Date
1910	Tulsequah	Summer	1991	Nolake	Aug 31 - Sep 2
1926	Tulsequah	January	1992	Nolake	August 18-21
1932	Tulsequah	August 18-21	1993	Tulsequah?	July 26-29
1942	Tulsequah	July	1994	Tulsequah	Jul 28- Aug 1
1943	Tulsequah	July	1994	Nolake	~ August 18
1944	Tulsequah	August 15-19	1995	Tulsequah?	July 24-27
1945	Tulsequah	August 8-11	1996	Tulsequah	prior to Sep 14
1946	Tulsequah	August 4-8	1996	Nolake	September 17-20
1947	Tulsequah	August 5-9	1997	Tulsequah?	July 25-28
1948	Tulsequah	July 23-27	1998	Tulsequah?	Jul 31 - Aug 1
1949	Tulsequah	August 7-10	1999	Tulsequah	June 20-22
1950	Tulsequah	July 27-30	1999	Nolake	August 16-18
1951	Tulsequah	July 26-29	2000	Tulsequah	June 13-15
1952	Tulsequah	August 6-9	2000	Nolake	July 24-26
1953	Tulsequah	July 6-10	2001	Tulsequah	July 21-24
1954	Tulsequah	September 11-14	2001	Nolake	August 8-10
1955	Tulsequah	September 4-7	2002	Tulsequah	June 15-17
1956	Tulsequah	Aug 29 - Sep 1	2002	Nolake	August 13-18
1957	Tulsequah	August 13-16	2003	Tulsequah	May 30 - June 2
1958	Tulsequah	July 7-10	2003	Nolake	August 7-11
1959-1971	Tulsequah	annually	2004	Tulsequah	July 13- 15
1974	Tulsequah	prior to Aug 31	2004	Nolake	June 23-26
1977	Tulsequah	prior to Aug 4	2005	Tulsequah	June 27-30
1982	Tulsequah	prior to 21 July	2005	Nolake	August 11 -14
1987	Tulsequah	August 25-28	2006	Tulsequah	June 29- July 2
1988	Tulsequah	Jul 31- Aug 2	2006	Nolake	August 8-11
1988	Nolake?	~ September 16	2007	Tulsequah	June 15-16
1989	Tulsequah	August 14-18	2007	Nolake	July 20-22
1990	Tulsequah	July 18-21	2008	Tulsequah	June 3-4
1990	Nolake?	~ August 20	2008	Nolake	August 18-19

The magnitude of these outburst floods is typically not sufficient to cause significant damage to property along the Tulsequah or Taku River. However, a local airstrip near the mine on the Tulsequah River is often inundated during these events. And deposits of debris and sediments result in changes to the river channels during and after the flood which can make both rivers dangerous to navigate. There are about 40 cabins located along the Taku River just west of the border, and some have experienced brief minor flooding during the larger jökulhlaups. Cabin owners prepare each summer for the anticipated outburst flood by plugging their boats, to prevent them from sinking, and moving all other loose items up and away from the river bank.

Residents of the small Southeastern community of Hyder are also very familiar with jökulhlaups. Summit Lake, located in a valley just north of the Salmon River and dammed on the southern end by the Salmon

Glacier, has been releasing on a fairly regular basis for the past 40 years. During these outburst floods, the flow of the Salmon River nearly triples, periodically washing out roads along the waterway. According to the Hyder cooperative observer, a dyke was built to protect the road that winds up along the river, but it was damaged by a flood in the early 1990s and has not been rebuilt.

Documentation of the Summit Lake releases has been uneven over the years. The records that are available indicate that in the early years (1960s), the lake emptied roughly every other year during the fall or early winter (October through December). But recently, the releases have been occurring almost annually and considerably earlier in the year (late July through early September).

The following table gives the known release dates of Summit Lake.

Year	Date	Damage	Year	Date	Damage
1961	December	major road/bridge damage	1994	Aug 29 - Sep 5	no
1963	November	no	1995	Aug 17 - 22	no
1965	December	2 roads washed out	1997	Jul 29 - Aug 3	no
1967	September	yes	1998	Jul 21- 26	no
1968	Nov 13 -19	minor	1999	Jul 30 - Aug 5	no
1970	Aug 2 - 9	3 1/2 mi of road washed out	2000	Jul 26 - 30	minor
1971	Aug 26 - 30	minor	2001	Aug 9 - 14	no
1972	Oct ? - 18	minor	2002	Jul 26- ?	
1973	Sep 17 - 22	major road damage	2003	Jul 30- ?	
1974	Sep 9 - 15	minor	2005	Jul 31- ?	Minor road wash out at 9 mile
1975	Aug 25 - 30	no	2006	Jul 7-12	
1976	Sep 3 - 9	no	2007	Jul 20-22	
1977	Nov 4 - 11	no	2008	Aug 20-24	

Jökulhlaups are difficult to predict due to seasonal variations in local weather patterns, precipitation, and temperature. However, they can be somewhat anticipated based on their history.

Glacial outburst flooding on the Taku River, can be monitored using the river stage and water temperature data from the USGS gage at Canyon island near the Canadian border. (Refer to http://ak.water.usgs.gov.) This gaging station is located in close proximity to most of the cabins in the area, and most cabin owners watch it carefully during the outburst events. A time series plot of water temperature reveals a dramatic cooling trend when the lake water discharge reaches the station, and the stage height increases steeply. Based on these observations, the National Weather Service in Juneau issues flood statements for the Taku River to help inform mariners, cabin owners and other recreational users when the outburst floods occur.

In Hyder, local experts keep a close eye on the water level at Summit Lake and help to inform the community's residents when a jökulhlaup is imminent. Since 1994, a fellow named Nate Lambert has camped at the lake during the summer, and his objective is to monitor and document the discharge. He notes the date when the lake level begins falling and the date at which the lake is empty. Lambert has found that the Salmon River crests two hours after all visible water is gone from the lake. (Mr. Lambert is actually a tourist; he lives in Williams, AZ.)